Volume 26 January, 1940 *Number 1*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

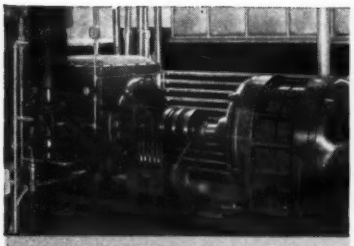
THIS ISSUE

Air Power and Compressor Lubrication

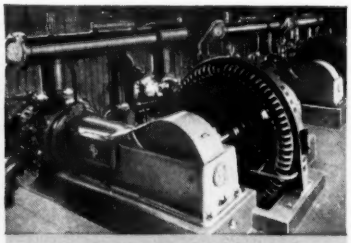
PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

Top Condition

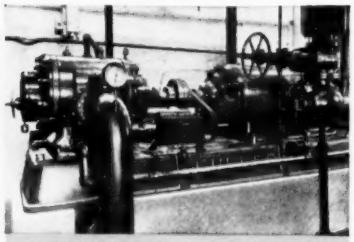
WHATEVER THE MAKE



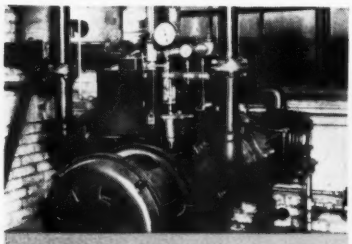
ALLIS-CHALMERS No. 521 Ro-Twin Compressor, 430 c.f.m., actual delivery at 100 lbs. gauge, driven by 100 h.p. motor at 720 r.p.m. showing lubricator.



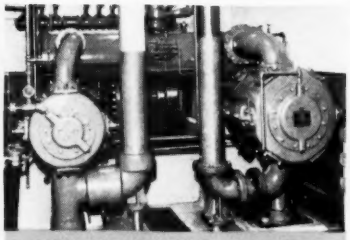
CHICAGO PNEUMATIC Type O-CE Compressors, 20–12x14, 1400 cu. ft. piston displacement in use on large tunnel job.



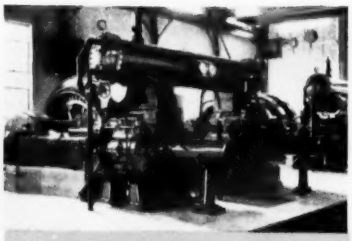
FULLER Rotary Two-Stage Compressor, 1775 c.f.m., 100 lbs. gauge at 650 r.p.m. with geared turbine drive, installed in copper refinery.



GARDNER-DENVER type "WB" vertical, 2-stage, water cooled Air Compressor, equipped with Duomatic Control, direct-connected to electric motor.

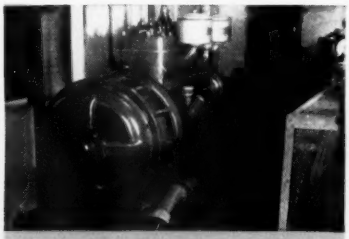


INGERSOLL-RAND 15 & 9¼ x 12 in. XRE Air Compressor and HM-2 after-cooler installed at plant of large northern manufacturing company.

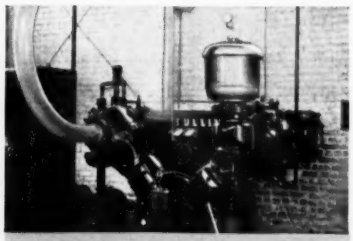


NORDBERG 2-stage Compressor, capacity 5220 c.f.m., 100 lbs. discharge pressure, driven by 900 h.p. motor, at 150 r.p.m.

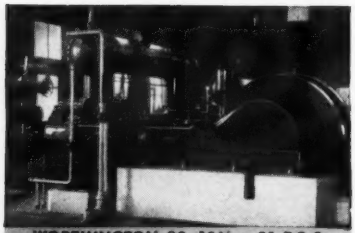
NORWALK Four-Stage Air Compressor, 275 c.f.m. at 3000 lbs. pressure, driven by Cummins Diesel in oxygen plant supplying air for liquefying.



SCHRAMM Air Compressor, 600 cu. ft. displacement, 420 cu. ft. delivery, direct-connected to 100 h.p. induction motor at a Brooklyn plant.



SULLIVAN Class WN-112 Heavy Duty Compressor, 2-stage, V-vertical type with built-in motor, 642 c.f.m. displacement at an Ohio plant.



WORTHINGTON 30, 18½ x 21 DC-2 Horizontal Duplex 2-stage Compressor driven by 600 h.p. engine-type synchronous motor in northeastern plant.

USERS of Texaco Alcaid, Algol, or Ursa Oils, in compressors of every make and type, valves stay clean, free from gum and carbon. They continue to operate efficiently over long periods. These oils keep compressors in peak condition, wear is minimized.

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LUBRICATION

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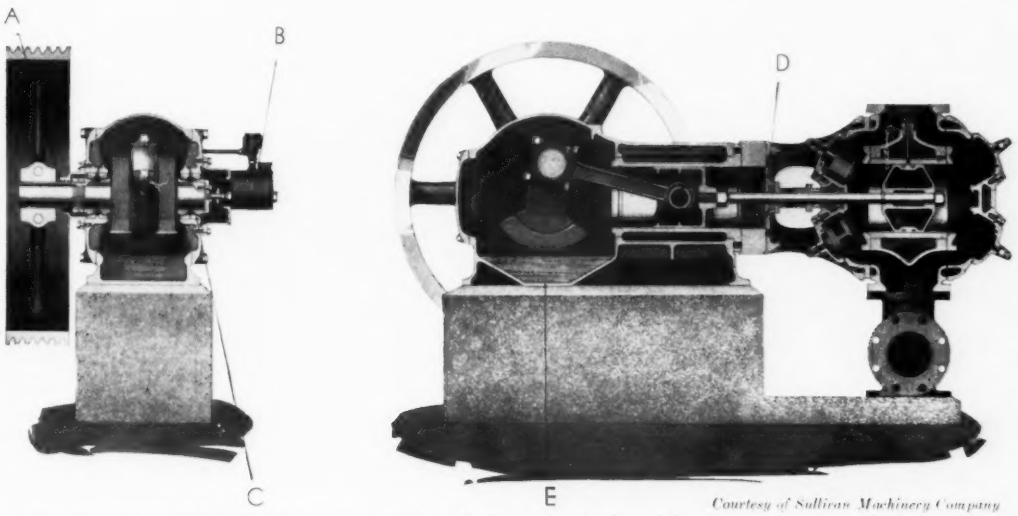
Air Power and Compressor Lubrication

UTILIZATION of air power has held a certain fascination for the research scientist since the days of antiquity, when those predecessors of modern science discovered that wind power could be applied to sails for moving boats. Later they discovered that air under pressure could be put to other uses. Probably the most notable was the development of the reed type of musical wind instrument which subsequently led to the invention of the pipe organ.

All this occurred prior to the Christian era. The use of compressed air as an adjunct to mechanics did not become practicable until the seventeenth century, when Galileo discovered that air had weight. Crude types of air pumps were then periodically developed, until compressed air came into its own as a medium



Courtesy of Sullivan Machinery Company

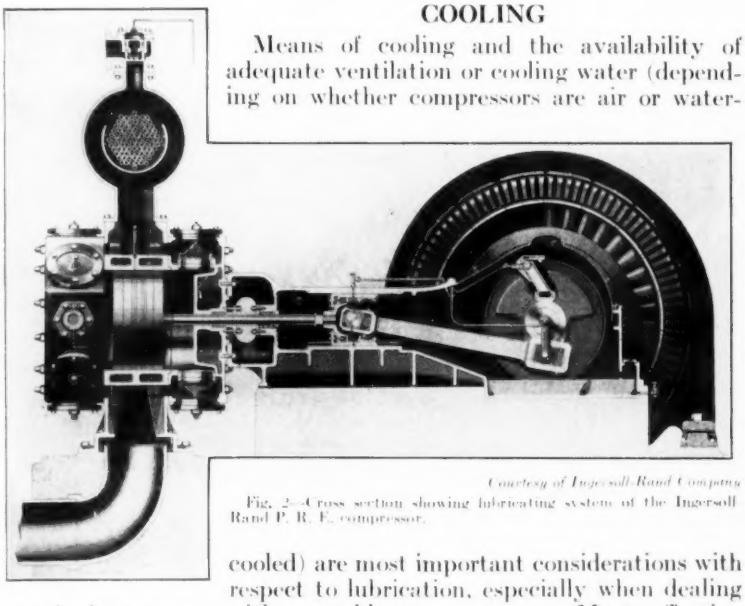
Fig. 1—Details of the Sullivan WG 8 compressor: "A" shows the labyrinth seal to keep oil in and contaminants out; "B" is the cylinder lubricator; "C" the double-row Timken bearings; "D" the wiper rings to prevent oil leakage from crankcase; and "E" the oil-tight crankcase

for driving machinery and operating tools. Then the full significance of air power was realized.

AIR POWER ASSOCIATED WITH HEAT

In the compressing of air heat is developed. It is caused by the rapid increase in the rate of impact between the molecules of the air which composes the charge being compressed. Actual friction contributes but little to the total amount of heat developed. Normally, most of the actual machine friction will be dissipated by radiation or conduction. All this does not imply, however, that the air compressor is a heat engine, for the heat developed during compression is largely removed from the compressed air by cooling before it is used.

Obviously, the machinery required to compress air must be lubricated. Furthermore, it must be lubricated at fairly high temperatures, cylinder oils, therefore, must be capable of withstanding heat with minimum tendency towards breakdown.

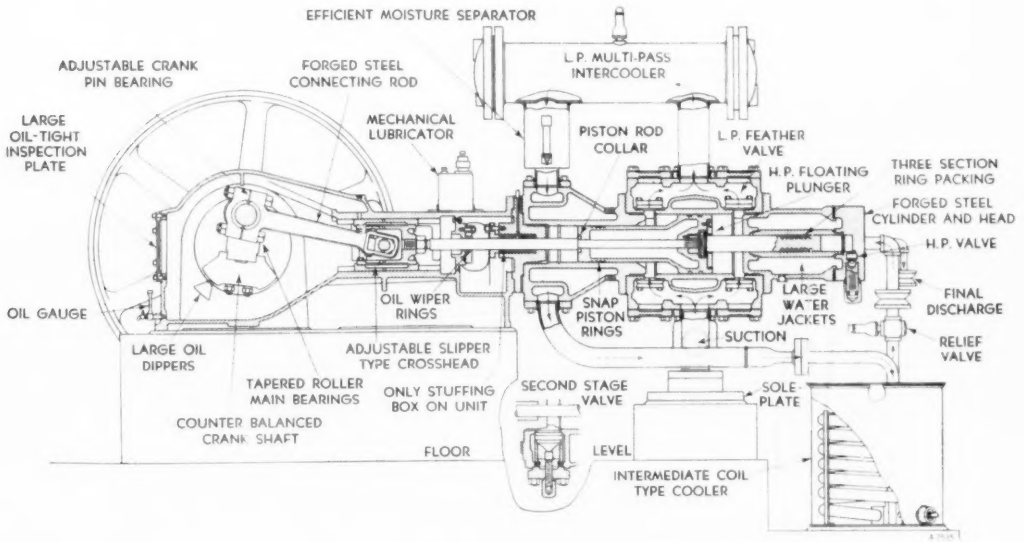


Courtesy of Ingersoll-Rand Company

Fig. 2—A cross section showing lubricating system of the Ingersoll-Rand P. R. E. compressor.

COOLING

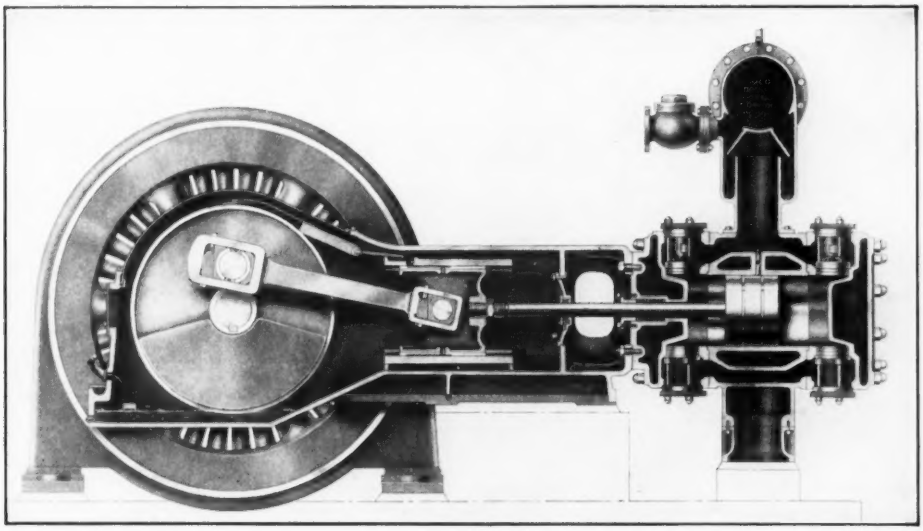
Means of cooling and the availability of adequate ventilation or cooling water (depending on whether compressors are air or water-cooled) are most important considerations with respect to lubrication, especially when dealing with portable compressors. Most effective lubrication is attainable where the walls can be kept sufficiently cool to preclude vaporization



Courtesy of Worthington Pump and Machinery Corp.

Fig. 3—Details of the Worthington single horizontal three-stage compressor. Note complete depiction of the lubrication mechanisms, and devices.

for the heat of compression is not removed until after discharge. So the pistons, cylinder walls or vanes according to the type of compressor are heated accordingly. Air compressor of the oil film. So compressor builders are most careful in their design to provide suitable fins for air-cooled cylinders, and to water-jacket those which must be water-cooled.



Courtesy of Chicago Pneumatic Tool Co.

Fig. 4—Section of a Chicago Pneumatic Compressor showing totally enclosed crankcase.

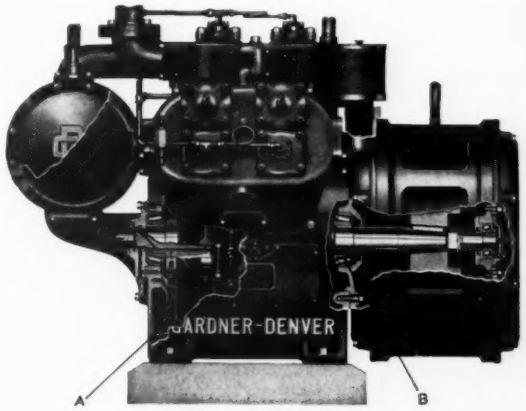
There may be considerable temperature variation in actual service, especially where circulation of cooling air is restricted, or where cooling water may have to be used repeatedly as in portable machines.

In single stage operation, it is customary to deliver air up to around 125 pounds pressure; above this figure it is most economical to stage or recompress the air, although 2-stage operation above 60 pounds is used by some builders for machines totaling more than 100 H.P. The air compressed by the first stage is intercooled before it goes to the second compression stage.

In other words, the intercooler connects the discharge of the first cylinder with the suction or inlet of the second cylinder. In case the air is to be still further compressed successively through additional cylinders, an intercooler is placed between each pair of cylinders. This intercooler is designed to contain a number of small tubes around which the air usually passes, and through which the cooling water circulates, although the air and water circuits are sometimes reversed. In this way the air, even when compressed to 1000 pounds or more per square inch, will be comparatively cool after leaving the last cylinder and the aftercooler.

So normal operation will rarely produce dangerous temperature conditions. On the other hand, normal operation is never an assured factor. The slightest air leak or deficiency developed in the working of the valves will lead to the building up of excessive temperatures due to hot air being drawn back into the cylinder and recompressed. If this is not corrected, it may lead to failure of some part of the system.

With regard to oil breakdown, all lubricating oils will be subject to more or less fractional distillation or separation under high temperatures. As this continues, the lighter portions evaporate and are carried off with the discharged air, the heavier fractions meanwhile remaining in the cylinder or collecting in the heads or on the valves. These oily deposits gradually thicken, carbonize, and collect any dust which may be drawn in with the air, finally developing to such an extent that they



Courtesy of Gardner-Denver Company

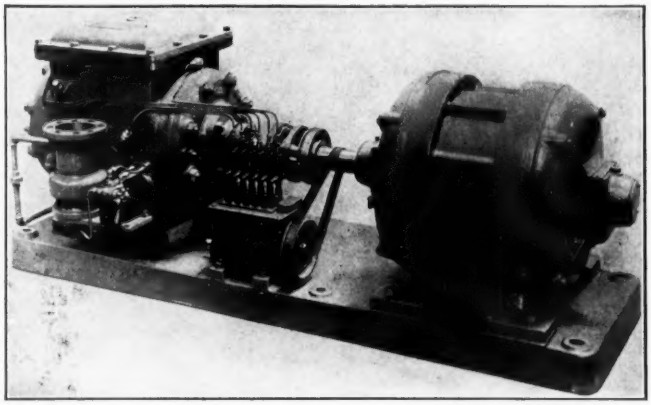
Fig. 5—Sectional views of a Gardner-Denver direct drive compressor assembly. "A" indicates the oil pump; "B" the Timken tapered main bearings.

may interfere with the operation of the valves. Hence the advisability of using a suitable air filter. It is usually the dust from the air in company with gummy oil deposits (known as carbonaceous matter) from improperly refined

oils, or excessive use of oil, which brings about faulty valve action.

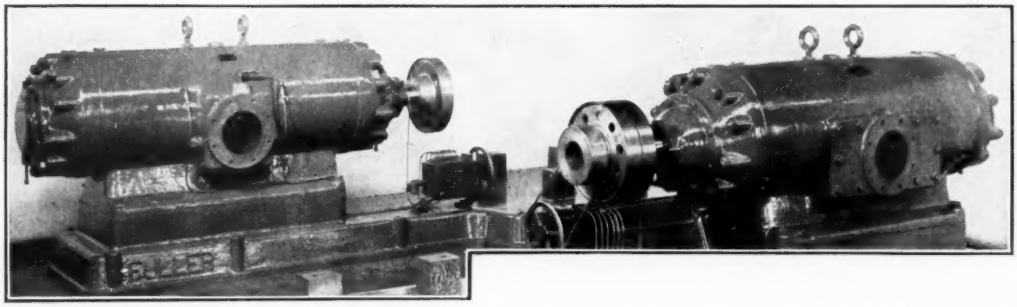
Intercooling Protects Lubrication

Intercooling where two or more stages are involved, assists in reducing the temperatures to which the lubricating oil is subjected. In company with aftercooling, it also aids in condensing oil vapors that may have been taken up by the compressed air and moisture from the latter. So wherever practicable, air should be suitably cooled to nearly the inlet temperature of the cooling water, or the atmospheric temperature of the air (in an air-cooled unit). This is more easily attained with water than air. If it can be accomplished, most complete condensation of the oil and moisture content will prevail. So the lubricating oil is protected, both in service as a lubricant, and afterwards, against blame as a possible cause of explosion, for even if it should be used to excess and not be entirely removed from the discharge air, the temperature of the latter, after suitable aftercooling, is normally too low to cause combustion or flashing of the oil.



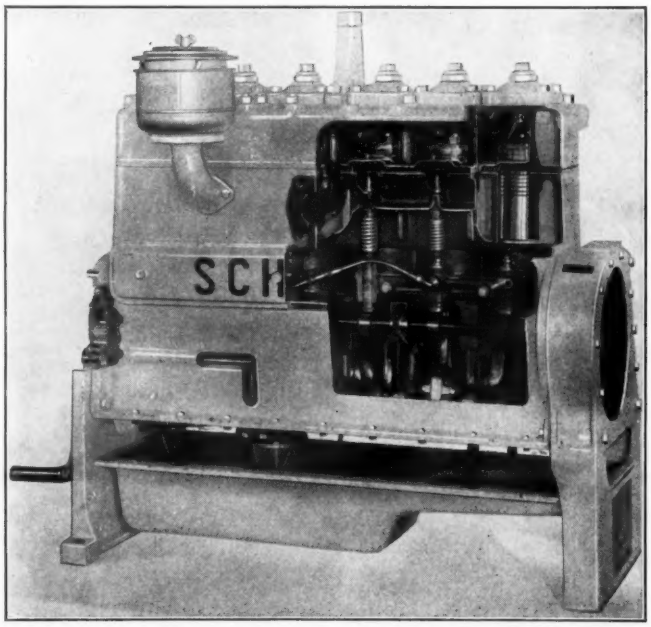
Courtesy of Allis-Chalmers Mfg. Co.

Fig. 6—The Allis-Chalmers "Ro-Twin" compressor showing lubrication system.



Courtesy of Fuller Company

Fig. 7—A pair of Fuller rotary compressors showing both the suction and discharge sides; also the lubricator mounting and oiling connections.



Courtesy of Schramm, Inc.

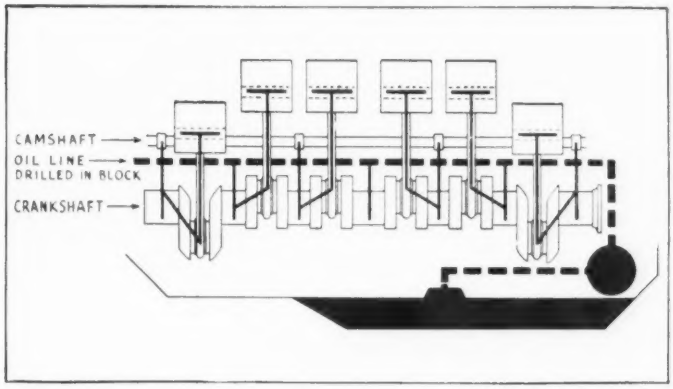
Fig. 8—Cut-away of the Schramm utility compressor showing details of head, intake valve, pistons and bearings.

Aftercooling Reduces Danger of Explosion

The aftercooler in turn is effective in correcting explosive conditions; it reduces the temperature of air discharged to the lines, and removes excessive oil vapors which may have formed due to improper lubrication.

COMPRESSOR OIL CHARACTERISTICS

Air compressor lubrication may present a problem due to the nature of the operating conditions to which the oil will be subjected.



Courtesy of Schramm, Inc.

Fig. 9—The force feed lubrication system of the Schramm Utility compressor.

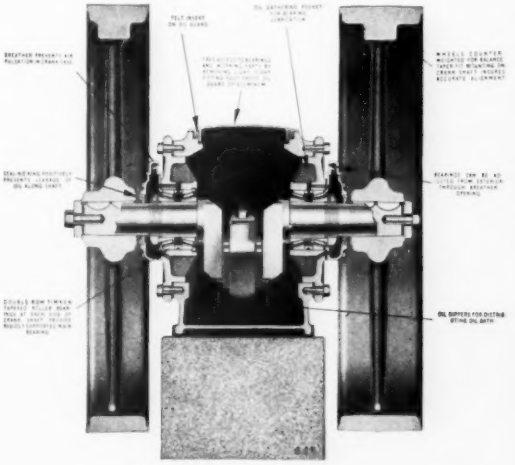
There may be a considerable temperature range (as already mentioned); furthermore, as this will probably approach quite a high maximum there may be considerable possibility of oil breakdown, with the accumulation of more or less carbon residue, according to its base and refinement. It is important to remember that we are normally lubricating enclosed mechanisms or interior surfaces which do not permit of easy inspection. They may be rotating or reciprocating, according to design, but all involve more or less sliding friction. Furthermore, load conditions may present an obstacle to effective lubrication, especially where high piston ring pressure is involved. Sometimes the operating conditions may be contradictory; for example, where a large, loose fitting piston might require a heavy cylinder oil, but where the speed conditions would indicate that a lower viscosity oil might function best. In addition, we must consider those several variables already mentioned, as well as the extent of compression.

Obviously, the function of lubrication is to prevent metal-to-metal contact. Theoretically, the variety of conditions which affect the performance of the oil might indicate that selection of the lubricant would be quite complicated. Actually, however, it can be confined mainly to a question of using an oil of the most suitable body or viscosity, with the added proviso that the oil be derived from selected low-carbon residue crudes.

Viscosity or body is of course related to piston ring or vane seal, according to the type of compressor; consequently, it affects compressor efficiency. If the oil is too light in body or of too low a viscosity it may not furnish the required seal at the peak temperatures of compression. This may result in increased oil consumption or air leakage. It goes hand in hand with the ultimate development of carbonaceous residues, for an increase in the rate of oil delivery is often the first thought; this puts more oil into the system, adding to the volume which may be subject to breakdown.

Conversely, if the oil is too heavy, or of too high a viscosity it may be sluggish at intake temperatures, subject to imperfect atomization, apt to have too much internal friction, and prone to hold non-lubricating foreign matter more tenaciously than a lighter oil. To be sure, it will also not be as readily subject to partial distillation, but when it does break down, the amount of carbon residue developed will be proportionately higher. The usual viscosity range for reciprocating compressor service will be from 200 to 500 seconds Saybolt Universal at 100 degrees Fahr. For rotary (blade type) units, somewhat heavier oils are preferred to maintain the vane seals, i.e., from 50 to 125 seconds at 210 degrees Fahr., according to the design and operating conditions.

The rotary type of compressor will normally require a heavier oil than the reciprocating



Courtesy of Pennsylvania Pump and Compressor Co.

Fig. 10—Section through the crankshaft of a Pennsylvania class 3-AT compressor. Note details of parts requiring lubrication.

machine (for the same compression range) due to the scraping action of the blades against the cylinder wall as they are impelled outward by centrifugal force on turning of the eccentric

Factors Which Control Dependable Compressor Operation

Successful performance of an air compressor cylinder oil is contingent upon the use of:

(1) **Controlled lubrication**—to insure positive feed of just sufficient oil to lubricate the cylinders properly. This can be judged by the condition of the valves and cylinders.

(2) **Clean cold air**—to reduce inlet temperatures as far as possible, and to prevent dust and dirt from entering the system.

(3) **Adequate circulation of cooling water**—to insure low cylinder wall temperatures, and hasten condensation of oil fog and moisture from air in the intercoolers and aftercoolers.

Do not use cylinder jacket cooling water at a temperature low enough to cause "sweating", or condensation of moisture from the intake air in the cylinder passages. Such moisture if condensed, will wash away the lubrication, resulting in unnecessary wear and possible damage. Enough water is circulating when the water at the outlet is lukewarm (**100 degrees to 120 degrees Fahr.**).

(4) **Soft water**—to prevent scaling of cooling water jackets.

(5) **Suitable intercoolers, and an aftercooler**—of sufficient size to permit condensation of oil mist and moisture carried over by the compressed air.

(6) **A receiver**—also to remove condensed oil vapor and moisture.

(7) **Periodic inspection**—

of valves—to note extent of lubrication, and whether carbon formations are accumulating. Clean if necessary.

of cooling water jackets—to note extent of scale formation. At same time clean if necessary.

(8) **Clean air cylinders**—prevent objectionable formations of non-lubricating materials.

(9) **A low carbon residue lubricating oil**—within the viscosity range desirable to meet the operating temperatures, piston ring tension and bearing clearance.

Factors Which May React Against Efficient Compressor Operation

The results obtained from an air compressor oil can in turn be affected adversely, and the efficiency of the entire system reduced, by certain unsuitable structural or operating conditions:

(1) **Excessive oil feed** which may lead to formation of objectionable carbon residues.

(2) **Development of oil pockets.** This is accelerated by using too much oil.

(3) **Accumulation of non-lubricating material** in the air lines, especially where an aftercooler is not provided. Oil mist and moisture will aggravate all this.

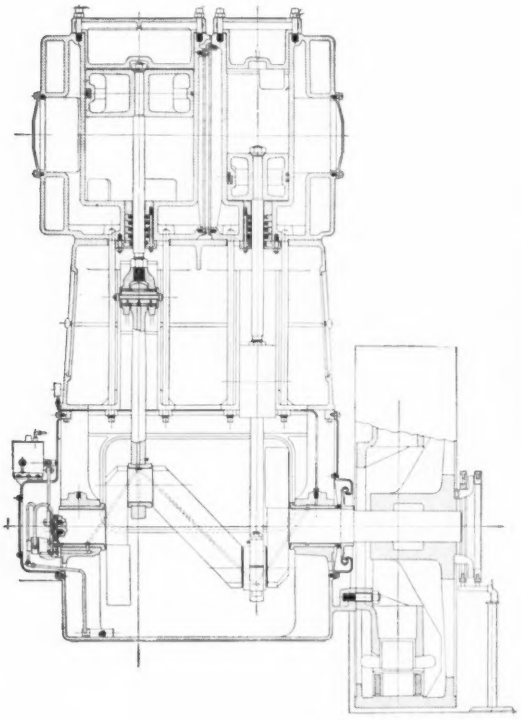
(4) **Too small a discharge pipe** due either to size or congestion. This will cause increased velocity of the compressed air, higher discharge temperatures and excessive power consumption.

(5) **Air leaks or blowby** due to leaky valves or stuck piston rings or valves, according to the type of compressor. This will lower the output, reduce the efficiency, and materially increase the discharge temperature.

(6) **Compression of dirty air**—which will cause scoring or abrasion of cylinder walls, piston rings, and valves, and hasten the formation of objectionable non-lubricating deposits. The solution is to use a suitable air filter, and locate the intake so that the air will be as cold and clean as possible.

(7) **Careless selection of lubricating oil** for the air cylinders.

rotor. Force feed lubrication delivers oil to the compressor; this oil must not only maintain a suitable film on the cylinder walls to provide a running surface for the blades, but



Courtesy of Nordberg Mfg. Co.

Fig. 11—Section of the Nordberg vertical type SC compressor. The cylinders are served by a mechanical force feed lubricator. All other parts are lubricated by a circulating pressure system.

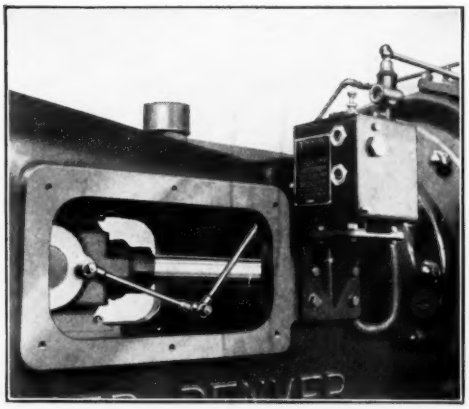
it must also lubricate the slots in which the blades slide.

The fact that oil dissipation by vaporization occurs in air compressor cylinder lubrication requires consideration of the flash point or that test which is indicative of the relative initial volatility of the oil. It is not the temperature at which boiling takes place, or at which a petroleum product may pass even partly over to the vapor stage. It merely shows when sufficient vapor has formed above the surface of the oil (in the test cup) to form an explosive mixture with air when exposed to a flame. Obviously, there should be no flame or spark in an air compressor, so the flash point is not a measure of explosion possibilities. It is, however, somewhat of a guide as to the base or crude from which a compressor oil has been refined, along with other physical properties such as the gravity and carbon residue content. The relation to the latter is particularly interesting. Oils which show the highest flash points will usually develop the most carbon residue. Furthermore, this may be of a hard, flinty nature, and resistant to removal, either with the discharged air or by mechanical means.

To connect the flash point with the possibility of compressor or airline explosion is irrelevant, unless some adverse condition of construction or operation has prevailed. For example, the use of dirty air, along with an unsuitable (gum forming) lubricating oil may have built up restrictions at fittings or bends in the air lines. Carbon is a poor conductor of heat, so whenever such obstructions have become extreme and are rendered incandescent by increase in air friction through venturi action, if the oil content in the air is high, failure of materials may occur due to loss of tensile strength through overheating, irrespective of the vaporization tendencies of the oil. Otherwise, the oil would have to be subjected to a temperature far in excess of the laboratory flash point, or even its spontaneous ignition temperature, before actual combustion through auto-ignition could occur.

Obviously, the safest procedure is to use sparingly a suitable compressor oil of the lowest possible carbon residue content, to see that the air is cool and clean, to periodically check the discharge valves for leakage and to be sure the oil has a high spontaneous ignition temperature. Naphthenic base oils have a higher spontaneous ignition temperature than paraffinic oils. The higher this temperature the lower the hazard, where combustible gaseous mixtures are involved.

Carbon residues are caused by exposure of lubricants to direct heat. This involves a



Courtesy of Gardner-Denver Company

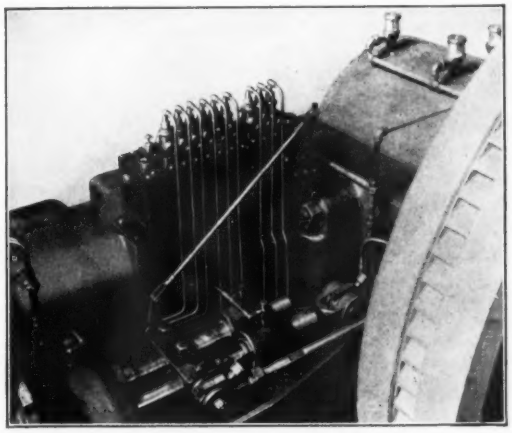
Fig. 12—Showing the mechanical force-feed air cylinder lubricator with driving mechanism as applied to a Gardner-Denver horizontal compressor.

chemical change in their structure. If this heat is sufficiently intense, it causes abnormal vaporization of the more volatile constituents to result in accumulation of non-lubricating

(oxidized) matter which may be of tarry or gummy nature. Continued exposure of the latter to heat causes coking or baking in piston ring grooves, on valves or elsewhere in the compressor. The cleaner an oil will vaporize the lower will be the amount of objectionable residues. The petroleum refiner controls this by narrowing the distillation range and studying the nature of the residual matter with respect to the viscosity of the resultant oils. Normally carbon residue will vary directly with the body or viscosity of an oil, as well as with the flash point. A wholly distilled compressor oil such as is customarily used for normal conditions (within the viscosity ranges mentioned above) should show a carbon residue content well below 0.50 per cent by the Conradson test. Any such residual matter should never be of a gummy nature, otherwise it would tend to hold any dirt or dust taken in with the air. So the latter should be as clean as possible; a suitable air filter will assure of this.

It is not always practicable, however, to use a wholly distilled oil. In marine Diesel air compressors, a small amount of fixed or animal oil such as lard oil must be added to develop a lathering effect with moisture and prevent corrosion or rusting during standby, especially in salt air localities. By the addition of compound, it is possible to maintain lubrication with normal oil feed; otherwise, were a straight mineral oil to be used the drops per minute would have to be raised. Even then there would be insufficient lathering or emulsification with moisture to assure that a protective film would remain on the contact surfaces when the machine is shut down.

Either procedure will in time lead to increased residual deposits. On vertical or marine compressors in damp atmospheres this is, however, of less importance than positive lubrication. Even so, any fixed oil compound should be used as sparingly as possible, for fixed oils are not subject to distillation under normal conditions. Instead, they will break down or decompose to tarry or gummy residual matter when exposed to high temperatures.

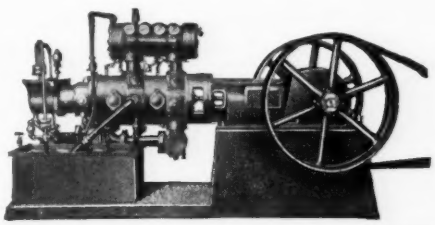


Courtesy of Ingersoll-Rand Company

Fig. 13—Side view of an I-R horizontal steam driven compressor showing details of the crankcase oiling system; and above the force-feed lubricator assembly which serves the steam and air cylinders. This unit is driven from the valve gear.

APPLICATION OF COMPRESSOR OILS

The means by which compressor oils are applied is a matter of considerable importance in the ultimate development of effective compressor lubrication. It is quite as vital as selecting oils of the proper physical characteristics, for, if the rate of oil delivery cannot be properly controlled, the possibility of future difficulties due to carbon formation will be increased. If an excess of oil is continually delivered to the cylinders, we must also realize that some of it must be carried over with the air to subsequently collect in the intercooler or in pockets elsewhere in the system. Conversely, too little oil may result in impaired lubrication.

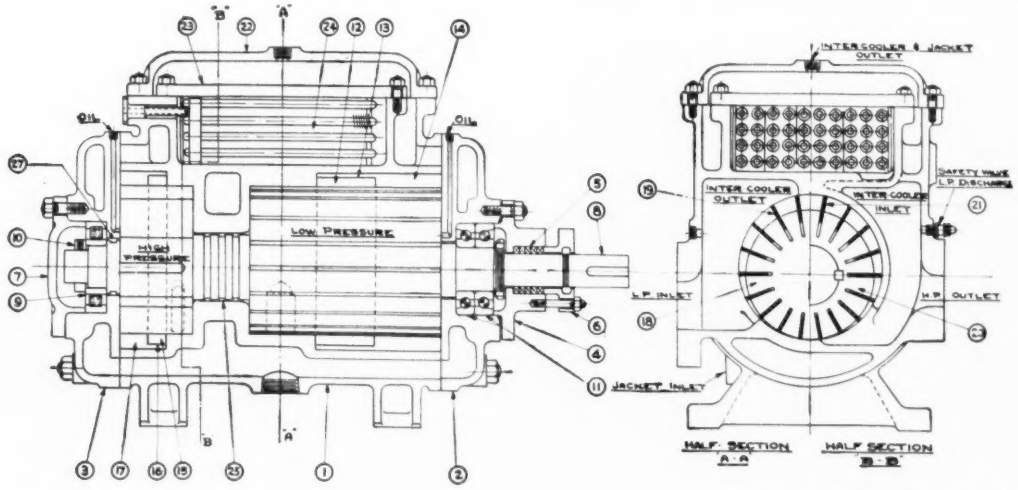


Courtesy of Norwalk Company, Inc.

Fig. 14—Side view of a Norwalk Universal four-stage compressor. Cylinders are served by a mechanical force-feed oiler driven from the running gear, or a sight-feed, positive pressure type of lubricator. The power end is usually splash lubricated.

Point of Delivery

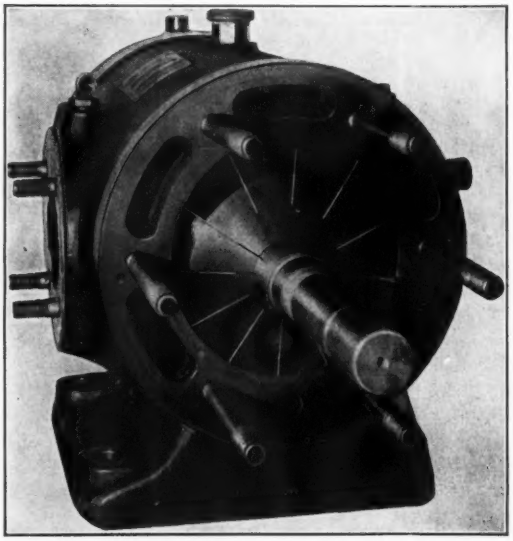
Air compressor oil will function best when it is completely distributed over the cylinder walls.



Courtesy of Allis-Chalmers Mfg. Co.

Fig. 15—Details of the Allis-Chalmers "Ro-Twin" Compressor.

The oil is usually pumped into the cylinders themselves by a mechanical force feed oiler.



Courtesy of Fuller Company

Fig. 16—The Fuller rotary compressor with head removed showing the end of the rotor, and blades in position as when running.

On account of the small amount of oil involved, and the fact that a filtered oil is more readily atomized, the lubricator is generally located fairly near the intake or cylinders, as atomization is effected in a relatively short distance of travel. In theory, about two drops a minute will suffice. As this may not afford sufficient oil at the uppermost parts of the pistons and cylinders in horizontal machines to insure satisfactory lubrication, the oil feed is usually increased above the usual theoretical requirements. This must not be done to excess, however, since it may lead to the collection of oil pockets in low parts of the system, to increase the possibility of explosion.

The Force Feed Lubricator

The force feed lubricator assures of a controlled flow of oil under pressure to each cylinder in a compressor. It is a most efficient and economical method of lubrication. By use of this device the possibility of over-feeding oil to any particular part is reduced, oil flow stops and starts with the compressor, and the requisite lubricating and sealing film is more nearly assured. Force feed lubricators are not affected by variations in air pressure, and they will feed the oil at the desired rate in accordance with their adjustment, the speed of the compressor, and the viscosity of the oil.

Type of Compressor Must be Considered

Different types of compressors will naturally involve certain variations in their lubrication; they may even require radical departure from what are normally classed as standard methods in this regard. In general, however, the force feed lubricator, an arrangement for pressure circulation, or adaptation of the principles of splash lubrication must be used, the application, etc., being planned according to the recom-

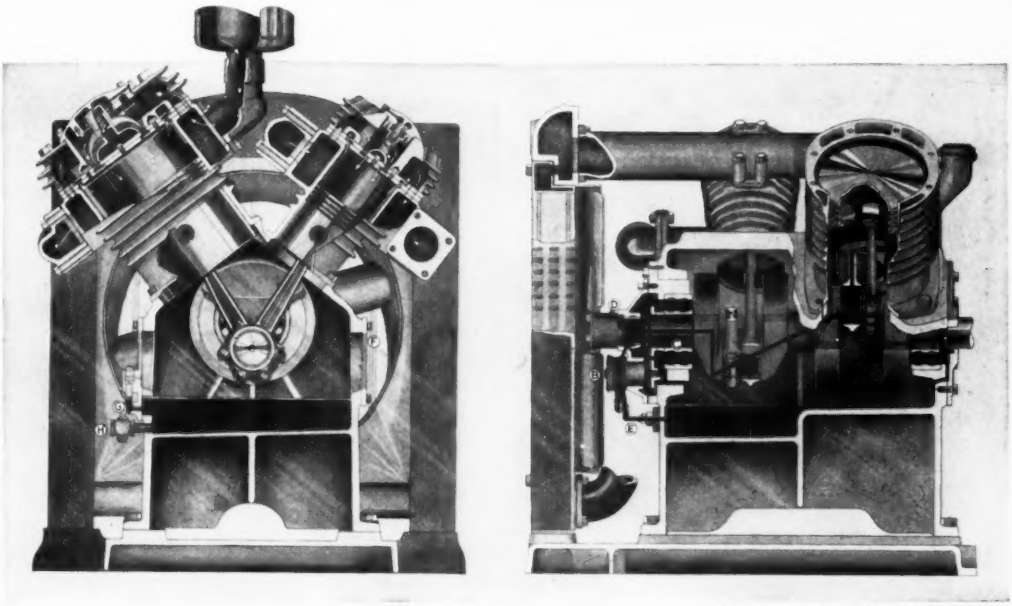
mendations of the compressor builder, based on the design of the machine, its size, capacity, and the character of the valves employed.

Flap and plate valves ordinarily require no lubrication. Other types of valves require either direct application of oil, or lubrication from the oil particles which are carried by the air.

So the operator or engineer is urged to consult with the builder of his machine either when planning on lubricator installations, etc., or when he feels that lubrication could be improved. As often as not, the oil is perfectly adapted to his machine requirements, the trouble being with the method of application.

Oil Control

It is inadvisable to establish any hard and fast rule in regard to the theoretically proper amount of oil that should be supplied to an air compressor cylinder. There are too many variables involved, such as the size of the compressor, its speed, and the condition of the piston and piston walls. The important point in any event is to guard against over-lubrication, inasmuch as more trouble will be caused by the use of too much rather than too little oil. The latter will probably remain in an air compressor cylinder considerably longer than in the cylinders of either a steam or internal combustion engine, owing to the fact that there is less atomization (due to lower temperatures) and little or no washing action or dilution of the oil film. As a consequence, very much less oil will be required per unit of cylinder surface over the same time interval. So the thoughtful operator uses just enough oil to prevent frictional wear and to permit easy and free operation of all parts.

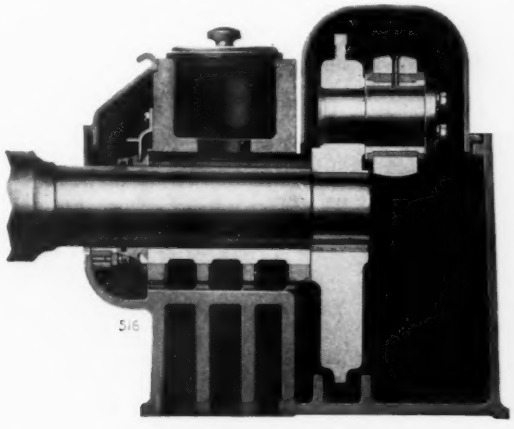


Courtesy of Sullivan Machinery Company

Fig. 17—Interior mechanism of the Sullivan "Unitair" compressor; "B" is the positive displacement oil pump; "C" shows the heavy duty ball main bearings; "D" are the crankshaft oil seals to keep oil in and dirt out; "E" is the oil strainer; "F" the oil-tight covers on the crankcase which permit ready inspection; "G" the oil level gauge; and "H" the crankcase oil drain.

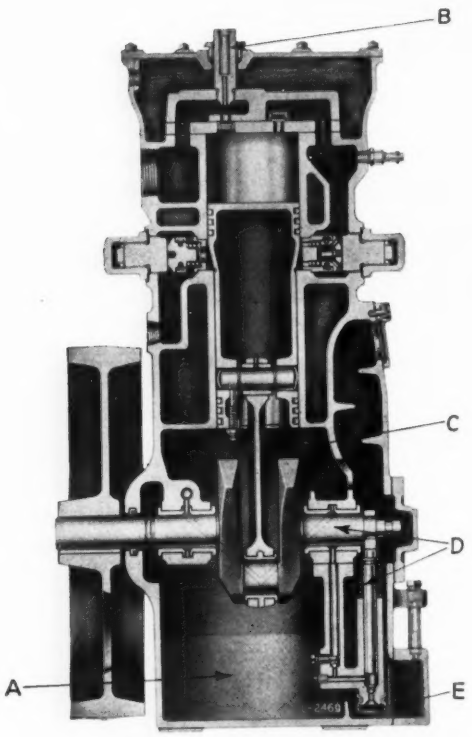
The discharge valves should be examined regularly, and the aftercooler, receiver, or discharge pipes periodically blown out.

This will effectively remove any oil, water or sediment which may have accumulated. Upon removal, if the discharge valves have a greasy



Courtesy of Pennsylvania Pump and Compressor Co.

Fig. 18—Section through the main bearing of a Pennsylvania duplex compressor showing oil seal in the shaft collar.



Courtesy of Worthington Pump and Machinery Corp.

Fig. 19—The Worthington two-stage heavy duty compressor. "A" is the oil reservoir; "B" the lubricator connection; "C" the drilled connecting rod for force-feed lubrication of the wrist pins; "D" the drilled shaft for additional oil circulation by the plunger oil pump; and "E" the oil strainer.

appearance, enough oil is being fed to the cylinders; on the other hand, if the parts appear very oily or little pools of oil are found in compressor pockets, or in any of the air lines, oil is being fed in excess of that required, or it has been improperly distributed.

Effects of Unsuitable Oils

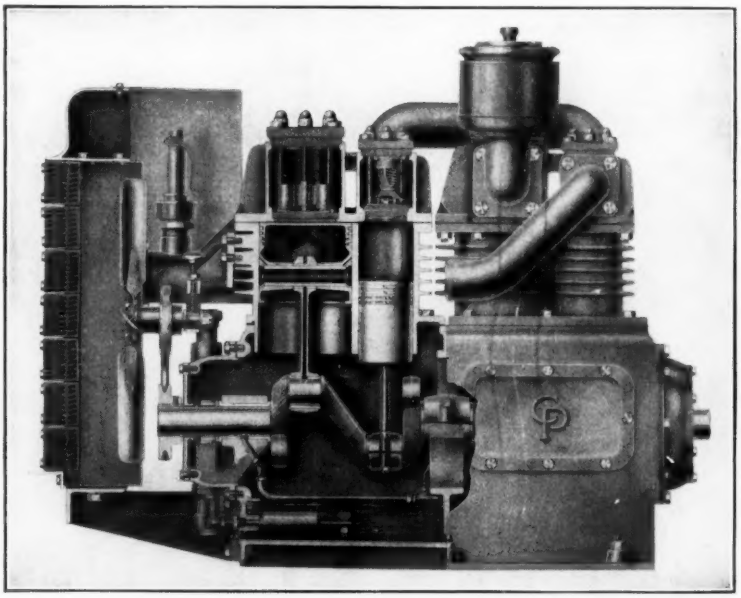
If an oil is unsuitable for compressor service, an excessive amount may be required to keep the pistons operating freely; but excessive oil will cause carbonization in the air passages, particularly on the discharge valves. Sticking of these valves, with the passage of hot compressed air back into the compressor cylinder, is generally indication of over-lubrication.

Amount of Oil Required

A time-honored rule states that from one to two drops of oil per 500 to 1500 square feet of cylinder area covered by the piston per minute (in reciprocating machines) should assure of adequate protection in average service. The size of the drops of any oil will vary with the viscosity, the temperature, the service conditions, the diameter and shape of the lubricator orifice, and the type or design of the lubricator, i.e., whether it is mechanical force-feed or sight-feed. So the number of drops per pint will vary. As a result, the number of drops secured per minute from an oil having a Saybolt viscosity of 200 seconds at 100 degrees Fahr. would differ from the number obtained from an oil of 300 seconds viscosity.

It, therefore, is not considered good practice to make an absolute recommendation as to the number of drops per minute that should be used in air cylinders of various sizes on account of the great variation in operating conditions that will be met with.

In fact, two compressors of the same design, same size, and built by the same manufacturer, may be operating in a room under identical conditions, yet it will be practically impossible to secure the same fit of piston rings and valves and the same polished cylinder surfaces. Experience has shown that two such compressors may require a surprisingly different amount of oil for air cylinder lubrication.



Courtesy of Chicago Pneumatic Tool Co.

Fig. 20—Showing the oiling system in the Chicago Pneumatic air-cooled portable compressor. Note provision for complete pressure circulation of the oil.

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Recommendations as above can at best be only approximate. It must be remembered that pressures, temperatures, clearances and operating speeds, or various combinations of these, may differ widely, thereby causing conditions that can be met only by individual consideration and a careful selection of lubricant.

For example, in many cases

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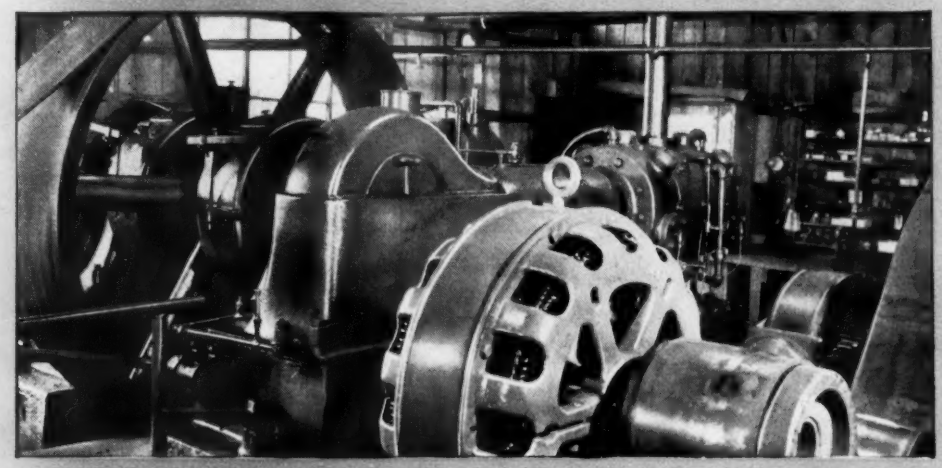
have been proved the most satisfactory product. Engineering advice is always expedient where any doubt exists.

Compressor Valves STAY CLEAN



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